PRESSURIZED VAPOR CYCLE LIQUID DISTILLATION

CROSS REFERENCE TO RELATED APPLICATIONS

[0001] This application is a Continuation of U.S. patent application Ser. No. 13/758,594 filed Feb. 4, 2013 and entitled Pressurized Vapor Cycle Liquid Distillation, now U.S. Pat. No. 10,507,403, issued Dec. 17, 2019 (Attorney Docket No. K31), which is a Divisional of U.S. patent application Ser. No. 11/480,294 filed Jun. 30, 2006 and entitled Pressurized Vapor Cycle Liquid Distillation, now U.S. Pat. No. 8,366,883, issued Feb. 5, 2013 (Attorney Docket No. E41), which is a Continuation-In-Part of U.S. patent application Ser. No. 10/713,617 filed Nov. 13, 2003 and entitled Pressurized Vapor Cycle Liquid Distillation (Attorney Docket No. D**91**), now U.S. Pat. No. 7,597,784, issued Oct. 6, 2009, which claims priority from the following applications: U.S. Provisional Patent Application Ser. No. 60/425,820 filed Nov. 13, 2002 and entitled Pressurized Vapor Cycle Liquid Distillation (Attorney Docket No. C48); U.S. Provisional Patent Application Ser. No. 60/490,615 filed Jul. 28, 2003 and entitled Systems and Methods for Distributed Utilities (Attorney Docket No. D90); and U.S. Provisional Patent Application Ser. No. 60/518,782 filed Nov. 10, 2003 and entitled Locally Powered Water Distillation System (Attorney Docket No. E08), each of which is hereby incorporated herein by reference in its entirety.

TECHNICAL FIELD

[0002] The present invention relates to liquid purification, and more particularly to liquid purification by vapor compression distillation comprising a liquid ring pump with rotatable housing having an internal liquid recovery system.

BACKGROUND OF THE INVENTION

[0003] A dependable source of clean water eludes vast segments of humanity. For example, the Canadian International Development Agency reports that about 1.2 billion people lack access to safe drinking water. Published reports attribute millions and millions of deaths per year, mostly children, to water related diseases. Many water purification techniques are well known, including carbon filters, chlorination, pasteurization, and reverse osmosis. Many of these techniques are significantly affected by variations in the water quality and do not address a wide variety of common contaminants, such as bacteria, viruses, organics, arsenic, lead, mercury, and pesticides that can be found in water supplies in the developing world and elsewhere. Some of these systems require access to a supply of consumables, such as filters or chemicals. Moreover, some of these techniques are only well suited to centralized, large-scale water systems that require both a significant infrastructure and highly trained operators. The ability to produce reliable clean water without regard to the water source, on a smaller, decentralized scale, without the need for consumables and constant maintenance is very desirable, particularly in the developing world.

[0004] The use of vapor compression distillation to purify water is well known and can address many of these concerns. However, the poor financial resources, limited technical assets, and low population density that does not make it feasible to build centralized, large-scale water systems in much of the developing world, also limits the availability of adequate, affordable, and reliable power to operate vapor compression distillation systems, as well as hindering the ability to properly maintain such systems. In such circumstances, an improved vapor compression distillation system and associated components increases efficiency and production capability, while decreasing the necessary power budget for system operation and the amount of system maintenance required.

SUMMARY OF THE INVENTION

[0005] In a first embodiment of the invention a liquid purification system is provided that advantageously may be compact, inexpensive, and easily maintained. One embodiment has a distillation device with a liquid ring pump and a rotatable housing with a single continuous shaft about which the liquid ring pump, motor and rotor rotates, and a second shaft supporting the rotatable housing, with an internal or external combustion engine, having motor rotor and magnets outside the fluid pressure boundary for the distillation system.

[0006] Another alternative embodiment has a distillation device with a liquid ring pump encased in a fully rotatable housing within the head vapor space of a still. Systemic heat sources can be redirected through a multi-line heat exchanger to maximize energy efficiency during the vaporization step. Back-wash lines may be directed to the intake from the head chamber of the evaporator/condenser, to keep unique flip-filters in the intake from fouling and to add heat into the heat exchange network. Further, a method of eliminating mist may be incorporated in the liquid ring pump component to eliminate contaminated liquid droplets entrained in the vapor and prevent them from being carried along to the condenser and thereby contaminating the purified product. One particular embodiment of the mist eliminator may have a top, a bottom and a housing wherein liquid is removed from suspension in vapor to an inner surface of the housing, the improvement comprising a plurality of vanes disposed along a diverter cone, wherein the diverter cone is situated at the bottom of said mist eliminator and wherein the vanes are angled to create a rotating motion to the vapor in the housing, a plurality of scales forming an angle .alpha. of at least about 15 degrees relative to a longitudinal axis Z of the housing, wherein the scales are situated to entrap liquid removed from suspension in vapor upon contact of the liquid with the scales, and each scale is in fluid communication with a gap between the scale and the inner surface of the housing of a dimension adapted to draw liquid through the gap to a collection area.

[0007] In related embodiments, the gap may be between about 0.025 and 0.05 inches, and may comprise a steam output for allowing steam to escape and/or a separator for collecting any liquid passing through the top of the mist eliminator.

[0008] Another particular embodiment has a distillation device with a liquid ring pump and a rotatable housing with a single continuous shaft about which the liquid ring pump, motor and rotor rotates, and a second shaft supporting the rotatable housing, with an internal or external combustion engine and siphon pump in a lower reservoir to siphon liquid into the chamber of the liquid ring pump. The result is a highly efficient, easily accessed and maintained, relatively simple and inexpensive system for purifying a liquid.